ENGINEERING INVESTIGATION OF IMPACT OF AQUEOUS FILM FORMING FOAM (AFFF) ON WASTEWATER TREATMENT PERFORMANCE NAVAL AIR STATION (NAS), MEMPHIS MILLINGTON, TENNESSEE

Grace & Associates
INCORPORATED

PRELIMINARY DRAFT

ARCHITECTURE • ENGINEERING • PLANNING • LANDSCAPE ARCHITECTURE

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1. EXECUTIVE SUMMARY

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As stated in the project description, the purpose of the study was as follows: "To determine the capability of the City of Millington, Tennessee wastewater treatment plant to satisfy National Pollutant Discharge Elimination System (NPDES) effluent standards while treating wastewater containing AFFF in quantities projected to be discharges from the existing and planned fire fighting training facilities at NAS Memphis".

The study was conducted over a continuous six week period and resulted in no noticeable changes in the treatment capabilities of the Millington plant. The methodology and daily results are listed in Section Four of this report. The basic conclusion determined by this study is that the Millington plant can accept AFFF in the concentrations projected from existing and proposed operations at NAS Memphis with no apparent detrimental effects on the plant's treatment capability or the quality of the effluent.

2. STUDY DESCRIPTION

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The purpose of the study was to determine the capability of the City of Millington wastewater treatment plant to receive the projected concentrations of AFFF from the fire fighting school at NAS Memphis once it is fully operational.

The study was divided into two phases, each phase lasting for three weeks. Phase 1 was to be completed and analyzed to ensure that no reduction in treatment at the Millington plant has been experienced prior to the start of phase 2. The intent of dividing the study into two phases was to "bracket" the actual concentrations of AFFF that the Millington wastewater plant would be subjected to once the fire fighting school was fully operational. From this premise it was determined by Mr. David McMinn of Naval Facilities Engineering Command, Charleston, using the best available information that the concentrations of AFFF should fall within the range of 20 ppm to 35 ppm based on an anticipated flow rate at the treatment plant of 2.7 MGD. Therefore; phase 1 was set up to provide a theoritical concentration of 20 ppm of AFFF, while phase 2 was set up to provide a theoretical concentration of 35 ppm. The AFFF was placed in the sewer system at a manhole close to the location of the fire fighting school to further ensure test parameters as close to actual conditions as possible.

Prior to the start of phase 1, the City of Millington wastewater treatment plant personnel and members of the study team held discussions and also toured the treatment plant. All operating records, influent and effluent sample analysis were reviewed, and guidelines were established to be followed during the course of the study period. Having established a

line of communications between the City of Millington, study personnel, and NAS Memphis, the decision was made to initiate the first phase of the study. The first phase was started on Monday, July 14, 1986. As discussed, an in depth review of all findings and results was conducted at the end of phase 1, prior to the start of phase 2.

If it was determined at this time that the Millington wastewater treatment plant was experiencing problems, the study would be terminated. As detailed in Section Four later in this report, the performance of the treatment plant was not affected by phase 1 of the study, and phase 2 was carried through to completion. Phase 2 was completed on August 24, 1986. An in phase 1, the treatment plant was not affected by the increased dosages in phase 2.

3. STUDY PROCEDURES & METHODOLOGY

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At the onset of the study period, the consultant was provided with the amounts of AFFF to be placed in the sewer system on a 24 hour per day basis. These amounts were estimated to approximate the anticipated discharge from the fire fighting school assuming a flow rate at the treatment plant of 2.7 MGD once it was fully operational. As initially intended, a metering pump provided by the consultant would be used to inject the AFFF into the sewer. However; because of the viscosity of the AFFF, or the harsh environment in which the metering pump operated, or a combination of these and other unknown factors, we were unable to keep a metering pump running for more than one week at a time. For this reason, it was determined that the most reliable method of metering the AFFF was to have it flow by gravity from a container of known volume directly into the sewer. A throttling valve was installed on the feed line to insure that the AFFF was feed into the system over a twenty-four hour period. Once this method was decided on, it was further decided that since the amount of AFFF to be feed into the sewer system varied each day, that a more consistant feed rate could be established if a known amount could be feed to the sewer system each day. Therefore; each day after the AFFF was placed in the container, water was added so that exactly 50 gallons of water and AFFF was to be feed each day to the sewer. In this way, once the throttling valve was correctly adjusted, regardless of the amount of AFFF to be fed on a specific day, the valve would not need adjustment. It was felt that the small amount of water introduced into the system in this way would not adversely affect the results of the study.

Influent and effluent samples were taken twice a week at the Millington wastewater treatment plant and analyzed by an independent testing laboratory. In addition, the City of Millington conducted their own tests on the influent and effluent. The results are exhibited in Section Four of this report.

4. RESULTS

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From all indications there was no adverse affect on either the treatment capability of the Millington plant or the effluent quality during the study period. Table 1 is a tabulation by day of the study period showing the injection rate of AFFF by the consultant, which is intended to simulate the dischate of AFFF from the proposed additions at the fire fighting school, the injection rate by the fire fighting school, the daily flow rate of treated wastewater at the Millington plant, and the daily concentration of AFFF treated by the Millington plant. It is noted that the concentrations are less than the anticipated levels because the flow rates at the Millington treatment plant were higher throughout the course of the study (3.94 MGD average) than estimated (2.7 MGD) during the study development stage.

No problems were encountered during phase 1 with the exception of the breakdown of the metering pumps as previously described. Phase 2 proceeded as smoothly until the second week of the phase. At this time we began experiencing problems with clogging of the drain line from the AFFF holding tank. As a result of this, during a one twenty-four hour period between August 13th and August 14th, approximately 82 gallons of AFFF were injected into the sewer system as shown in Table 1. This amount of AFFF should have been injected over a two day period. This concentration resulted in a fairly substantial foam build up at the Millington plant's grit chamber. Plant operating personnel were able to disperse the foam, and no adverse effects were caused by this large dosage of AFFF. We feel

that this may be the threshold tolerence level of the Millington plant, as far as foaming problems are concerned. Apparently; however, the dosage required to actually cause a reduction in the treatment capability of the plant is somewhat higher as no significant reduction in treatment was recorded at any time throughout the study duration.

No other cases of foaming at the treatment plant were reported during the study. However; on three other instances July 25, August 21, and August 22, estimated concentrations of AFFF exceeded the concentrations encountered at the Millington plant on August 14, the day the foam problems were encountered in the grit chamber. A review of Table 1 shows that in all three instances, unusually large amounts of AFFF were used by the fire fighting school on those days. Since no foam appeared at the treatment plant on those days, it is reasonable to assume that either the AFFF used by the school did not reach the sewer or a large portion of the AFFF was not actually used and remained in the trucks.

Appendix A of this report contains the laboratory analysis of the influent and effluent of the Millington plant conducted by an independent lab during the course of this study. Appendix B contains the lab analysis conducted by Millington personnel for a month prior to the study, during the study, and one month after conclusion of the study. These lab analysis are completed in tabulation form for ease of cross-reference in Table 2 of this report. There are slight, but consistant differences between the Millington lab and A & L Lab results; however, it is felt these differences are caused primarily by different testing techniques and different laboratory equipment. Appedices C, D, and E are offered for general information. They contain daily flow rates for both the Naval Base as well as the treatment plant, and analysis of the discharge from the base.

TABLE NO. 1

STUDY DATE	STUDY INJECTION AMOUNT (AFFF) (GALLONS/DAY)	FIRE FIGHTING SCHOOL DISCHARGE AMOUNT (AFFF) (GALLONS/DAY)	MEASURED DISCHARGE MILLINTON WASTE-WATER TREATMENT PLANT (MGD)	CONCENTRATION (AFFF) (PPM)
14JUL86	16.8	10	4.046	6.62
15JUL86	17.2	0	4.122	4.17
16JUL86	4.3	5	4.153	2.24
17JUL86	18.1	0	4.219	4.29
18JUL86	36.1	30	4.031	16.4
19JUL86	44.7	0	3.793	11.8
20JUL86	25.8	0	3.753	6.87
21JUL86	19.4	0	3.951	4.91
22JUL86	12.9	0	3.827	3.37
23JUL86	17.6	5	4.036	5.60
24JUL86	22.8	0	4.029	5.66
25JUL86	22.8	105	3.847	33.2
26JUL86	27	0	4.23	6.38
27JUL86	27	0	3.791	7.12
28JUL86	19	0	4.11	4.62
29JUL86	19	0	4.196	4.53
30JUL86	17	5	4.126	5.33
31JUL86	27	0	4.029	6.70
1AUG86	19	10	4.092	7.09
2AUG86	27	0	3.95	6.84
3AUG86	27	0	3.621	7.46
4AUG86	39	0	3.709	10.5
5AUG86	39	10	3.805	12.9
6AUG86	37	5	3.931	10.7
7AUG86	47	10	4.174	13.7
8AUG86	39	5	3.979	11.1
9AUG86	47	0	3.918	12.0
10AUG86	47	0	3.8	12.4
11AUG86	39	0	3.879	10.1
12AUG86	39	0	3.81	10.2
13AUG86	77	5	3.721	22.0
14AUG86	47	0	4.034	11.7
15AUG86	39	0	3.912	9.97
16AUG86	0	0	4.326	0
17AUG86	47	0	3.786	12.4
18AUG86	39	0	3.9	10
19AUG86	39	0	3.951	9.87
20AUG86	38	5	3.851	11.2
21AUG86	47	55	3.93	26.0
22AUG86	39	60	3.504	28.3
23AUG86	47	0	3.836	12.3
24AUG86	47	0	3.781	12.4

TABLE 2

SAMPLE DATE	ANALYSIS PERFORMED	ALL LABORATORIES INFLUENT/EFFFUENT			MILLINGTON WASTEWATER TREATMENT PLANT INFLUENT/EFFLUENT		
15JULY86	BOD (5 DAY) (mg/l)	123	/	<1	68	/	4.8
	COD (mg/l)	274	/	18			
	Oil & Grease (mg/l)	26	/	2			
	pH (Standard Units)	7.3	/	7.6			
	Suspended Solids (mg/l)	186	/	<1	138	/	5.8
	Turbidity (NTU)	78	/	0.5			
	Color (Units)	25	/	15			
17JULY86	BOD (5 DAY) (mg/l)	114	/	1<	107	/4.5	
	COD (mg/l)	335	/	19			
	Oil & Grease (mg/l)	20	/	<1			
	pH (Standard Units)	7.4	/	7.7			
	Suspended Solids (mg/l)	212	/	<1	176	/	2.8
	Turbidity (NTU)	118	/	0.5			
	Color (Units)	25	/	10			
21JULY86	BOD (5 DAY) (mg/l)	66	/	1	81	/	7.6
	COD (mg/l)	146	/	19			
	Oil & Grease (mg/l)	13	/	4			
	pH (Standard Units)	7.4	/	7.7			
	Suspended Solids (mg/l)	61	/	<1	133	/	1.4
	Turbidity (NTU)	85	/	0.6			
	Color (Units)	10	/	10			
24JULY86	BOD (5 DAY) (mg/l)	64	/	<1	78.8	/	6.0
	COD (mg/l)	160	/	18			
	Oil & Grease (mg/l)	12	/	3			
	pH (Standard Units)	7.4	/	7.7			
	Suspended Solids (mg/l)	68	/	<1	95	/	1.4
	Turbidity (NTU)	36	/	0.8			
	Color (Units)	15	/	10			
28JULY86	BOD (5 DAY) (mg/l)	84	/	<1	114.6	/	5.5
	COD (mg/l)	232	/	15			
	Oil & Grease (mg/l)	16	/	2			
	pH (Standard Units)	7.7	/	7.9			
	Suspended Solids (mg/l)	128	/	<1	111	/	2.4
	Turbidity (NTU)	58	/	0.9			
	Color (Units)	25	/	10			
31JULY86	BOD (5 DAY) (mg/l)	109	/	<1	132.7	/	7.1
	COD (mg/l)	368	/	4			
	Oil & Grease (mg/l)	19	/	<1			
	pH (Standard Units)	7.6	/	7.8			
	Suspended Solids (mg/l)	359	/	<1	349	/	2.2
	Turbidity (NTU)	170	/	1.5			
	Color (Units)	25	/	10			
4AUG86	BOD (5 DAY) (mg/l)	116	/	2	136	/	5
	COD (mg/l)	225	/	11			
	Oil & Grease (mg/l)	22	/	3			
	pH (Standard Units)	7.5	/	7.8			
	Suspended Solids (mg/l)	130	/	9	148	/	1.4
	Turbidity (NTU)	78	/	6.5			
	Color (Units)	35	/	10			

TABLE 2 (CONTINUED)

SAMPLE DATE	ANALYSIS PERFORMED	A&L LABORATORIES INFLUENT/EFFFUENT	MILLINGTON WASTEWATER TREATMENT PLANT INFLUENT/EFFLUENT
7AUG86	BOD (5 DAY) (mg/l)	184 / 1	182.5 / 4.85
	COD (mg/l)	205 / 4	
	Oil & Grease (mg/l)	18 / 3	
	pH (Standard Units)	7.2 / 7.5	
	Suspended Solids (mg/l)	135 / <1	134 / 2.2
	Turbidity (NTU)	70 / 0.8	
	Color (Units)	30 / 10	
11AUG86	BOD (5 DAY) (mg/l)	114 / <1	91.9 / 3.7
	COD (mg/l)	290 / 4	
	Oil & Grease (mg/l)	23 / 3	
	pH (Standard Units)	7.4 / 7.8	
	Suspended Solids (mg/l)	126 / <1	102 / 1.2
	Turbidity (NTU)	72 / 1.5	
	Color (Units)	25 / 10	
14AUG86	BOD (5 DAY) (mg/l)	117 / 1	98.5 / 5.0
	COD (mg/l)	240 / 22	
	Oil & Grease (mg/l)	16 / 4	
	pH (Standard Units)	7.5 / 7.7	
	Suspended Solids (mg/l)	166 / <1	128 / 1.2
	Turbidity (NTU)	73 / 3.4	
	Color (Units)	25 / 10	
18AUG86	BOD (5 DAY) (mg/l)	102 / <1	145.5 / 7.3
	COD (mg/l)	275 / 15	
	Oil & Grease (mg/l)	15 / 4	
	pH (Standard Units)	7.2 / 7.7	
	Suspended Solids (mg/l)	108 / <1	120 / 1.6
	Turbidity (NTU)	65 / 1.3	
	Color (Units)	25 / 10	
21AUG86	BOD (5 DAY) (mg/l)	106 / <1	107.5 / 4.4
	COD (mg/l)	210 / 18	
	Oil & Grease (mg/l)	21 / 2	
	pH (Standard Units)	7.6 / 7.8	
	Suspended Solids (mg/l)	119 / <1	126 / 1.4
	Turbidity (NTU)	80 / 1.1	
	Color (Units)	30 / 10	
25AUG86	BOD (5 DAY) (mg/l)	110 / 1	129 / 5.35
	COD (mg/l)	300 / 18	
	Oil & Grease (mg/l)	19 / 3	
	pH (Standard Units)	7.4 / 7.6	
	Suspended Solids (mg/l)	120 / <1	127 / 2.2
	Turbidity (NTU)	65 / 2.0	
	Color (Units)	35 / 10	

5. SUMMARY & CONCLUSIONS

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As stated several times throughout this report, there has been no discernable effect on the treatment capability of the Millington plant nor a reduction in its effluent quality. The only visable or measurable effects to date is the one instance of foam in the grit chamber as discussed, and the possible minor change in the appearance of the scum in the oxidation ditch. The observation about the scum appearance is inconclusive because the sludge age was being adjusted by plant personnel during the course of the study. This adjustment could have altered the scum's appearance. In any event, treatment was not affected.

In conclusion, it appears the Millington plant is capable of maintaining its high quality of effluent throughout the anticipated ranges of concentrations of AFFF to be discharged from the fire fighting school. Approximately 82 gal. per day of AFFF appears to cause minor foaming problems at the front of the plant. Concentrations at this level; however, do not appear to affect treatment. From this, it can be assumed that this would be a good indicator to plant personnel that a spill or failure at the retention basin has occurred. Officials at the fire fighting school should be notified immediately, and measures taken to correct the problem.